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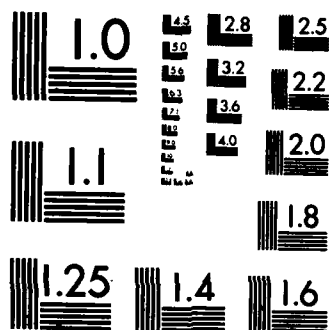   AEROSPACE CONTRACTORS(U) NAVAL POSTGRADUATE SCHOOL
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THESIS

AN ANALYSIS OF THE PROFITABILITY OF
MAJOR DEFENSE AEROSPACE CONTRACTORS

by

David Francis Britt

September 1983

Thesis Advisor: W. R. Greer, Jr.

89

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This study is a comparative analysis between the profitability of defense and commercial aerospace business. Corporate data including profit measures and the volume of defense business were collected for a 22 year period from 1961 to 1982. The methodology uses regression analysis with the percentage of defense business and the percentage of capacity utilization within the aerospace industry as the explanatory variables for

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Briefly the findings indicate; that defense contracting has,
on the average, been less profitable than commercial; that con-
tractors earn more on defense contracts during periods of
increased capacity utilization, and that defense contracting
involves higher risk. The author concludes that government
acquisition managers must be continuously aware of the impli-
cations of these findings for individual contractors as well
as for the entire defense industrial base.

An Analysis of the Profitability of
Major Defense Aerospace Contractors

by

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Lieutenant, United States Navy
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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This study is a comparative analysis between the profitability of defense and commercial aerospace business. Corporate data including profit measures and the volume of defense business were collected for a 22 year period from 1961 to 1982. The methodology uses regression analysis with the percentage of defense business and the percentage of capacity utilization within the aerospace industry as the explanatory variables for profit. Finally, a brief analysis of risk is included to provide a framework within which to compare these profit levels. Briefly the findings indicate; that defense contracting has, on the average, been less profitable than commercial; that contractors earn more on defense contracts during periods of increased capacity utilization, and that defense contracting involves higher risk. The author concludes that government acquisition managers must be continuously aware of the implications of these findings for individual contractors as well as for the entire defense industrial base.

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I. INTRODUCTION

A. GENERAL BACKGROUND

Each year, the Department of Defense spends billions of
dollars to procure new military hardware. Modern sophisti-
cated weaponry is very expensive and therefore the industry
which serves the nation must be as efficient and cost-
effective as possible.

It is generally assumed that competitively-awarded,
fixed-price contracts yield the vendor a satisfactory and
"fair" profit in an efficient marketplace. Unfortunately,
over 80% of DOD's procurement dollars are spent using con-
tracts in which the price, cost and profit is negotiated.
The government must become concerned with the size of the
profit allowed on these contracts because the normal mecha-
nisms of an otherwise freely competitive marketplace may be
disrupted if prices are negotiated. If profits are too
high, the government is not spending the public's money
wisely. But if profits are too low, the contractor may
refuse to accept government business. A result might be
that defense dollars would be able to procure progressively
less hardware as lower profits attract fewer producers. In
the long run, the government may find a private industry
which is unwilling to, or worse yet incapable of, providing
strategically essential goods. [Ref. 1]

B. SPECIFIC ISSUES

The importance of profit in the structure of the DOD-contractor relationship is evident in the Defense Acquisition Regulation [Ref. 2]. DOD policy states that profit is to be utilized to stimulate efficient contract performance as profit is recognized to be the basic motive of business enterprise. Deputy Defense Secretary Clement stated before the Joint Committee on Defense Production [Ref. 3] that ti. , same profit policy must be used to strengthen the defense industrial base. Clements goes on to say that a "fair" level of profitability on defense business works to the government's advantage by attracting good performers, maintaining a healthy competitive environment, and enabling contractors to invest in new plants and equipment.

The reluctance of defense contractors to invest in more efficient new equipment was attributed to relatively low levels of profitability by Profit '76 [Ref. 3]. Profit policy adjustments were made subsequent to this study to encourage contractors to increase their capital investments. DOD intended that in addition to upgrading the industrial base, the higher productivity achieved through modernization would ultimately translate into lower procurement costs. However a GAO review [Ref. 4] in 1979 found that although negotiated profits had indeed climbed, capital investment had not increased. Nor was it obvious that any cost savings had been realized.

Another four years have passed since the GAO review, and
DOD is embarking on a new Acquisition Improvement Program.
Perino states [Ref. 5] that the root cause of many system
acquisition problems being addressed by the new program is
the historical attempt to limit profit on defense contracts.
He further argues that lower profitability translates into
lower equity investment which results in lower productivity
and increased acquisition costs. His statements in 1983
echo the conclusions drawn from Profit '76.

Of course a second alternative for defense contractors
faced with low profit levels from defense work is to simply
not to compete. A report titled "The Ailing Defense Indus-
trial Base: Unready For Crisis" [Ref. 6] reported that
between 1967 and 1980 the number of companies in the base
had dropped from 6,000 to 3,500. Aerospace have had a grow-
ing commercial alternative to defense work as signaled by a
drop in government sales as a percentage of total sales for
Standard and Poor's Aerospace Industry from 69% to 48%
between 1971 and 1980 [Ref. 7].

Although much of the evidence argues for inadequate
profits from defense contracting, the facts are that many
firms still do compete for these supposedly "low profit"
contracts. Many large defense contractors are quite prof-
itable, and the feeling is that defense contracts can be
very lucrative. Being awarded the contract is the only

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incentive for defense contractors to limit costs on their
contract proposals given that profits are initially nego-
tiated as a percentage of this figure. On those occasions
when historical cost data is unavailable or there is only
one source, the contractor can take advantage of the situa-
tion to pad his proposal. In this instance defense business
could be used as a training ground for new personnel, or as
a means of retaining experienced personnel when business is
slow, making it more "profitable" than the bottom line would
indicate. Presumably aerospace firms wouldn't compete if
profits were considered "too low," leaving the instinctive
impression that there may be more to this controversy than
meets the eye.

Numerous studies conducted over the past two decades
have sought to provide answers to the controversy surround-
ing the profitability of engaging in Department of Defense
(DOD) contracts. [Ref. 8] The question of insufficient,
adequate, or excessive profits on DOD weapons acquisition
programs is an ongoing one due to several factors. Ideally,
defense business should compete equally with commercial
business for available industrial capacity. This explains
the common practice of looking for "parity" in the profita-
bility of like government and commercial goods. Normally,
if a given type of business provided less than expected
returns, market forces would act to reduce competition for.

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this business and might eventually eliminate it. Such is
not the case with the Department of Defense due to the
monopsonistic nature of the government-industry relation-
ship, wherein at least some of the free market forces men-
tioned are bypassed. The ability of DOD, through its
acquisition regulations, to exercise significant control
over profit levels is a market imperfection which consti-
tutes a major variable in the solution. [Ref. 9]

Another factor contributing to the evolution of the
debate has been the inability to agree on the relative risks
associated with defense contracting. A study conducted by
the Conference Board [Ref. 10] contained interviews of 53
account executives from 31 financial institutions. The con-
sensus was that defense business was not sufficiently prof-
itable for the risks involved. Whether or not the banker's
opinion is correct may not be as important as their indis-
putably heavy influence over the availability of funds for
defense industry loans. Proponents of the low risk view-
point, on the other hand, cite such sureties as cost-based,
"negotiated" profits, Government financing through progress
payments, and a redirection of acquisition policy toward
reducing contractor risk, as evidence for their contention.

The politically charged characteristics of DOD acquisi-
tion procedures does nothing to stabilize the issue. Con-
gressional exposés of a few poorly managed contracts not

only drive industry and the services into opposing camps, they also promote a long-term adversarial relationship in which both sides are prone to disagree on the adequacy of defense contract profitability. [Ref. 10]

Whatever the answer to the profit question, there is little disagreement on the ramifications of inadequate profits for defense contractors. Woody [Ref. 11] proposes that defense business may become a "market of last resort," attractive only to less efficient companies. A reduction in the quality of the competitors would further exacerbate the quantifiable erosion of the industrial base previously noted.

C. RESEARCH QUESTIONS

In this study, the objective is to analyze available published data with a goal of providing answers to the following questions:

(1) How profitable have major aerospace firms been in their defense and nondefense business?

(2) Does the profitability level of defense contractors reflect the degree of capacity utilization in the aerospace industry?

(3) Are the profits associated with defense and commercial business consistent with their respective risks?

The answers to the questions raised above can provide valuable insights into the behavior of contractors when

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dealing with DOD contracts. The answers also have significant implications for DOD profit policy and its goal of attracting a large number of the best contractors to defense work.

D. RESEARCH METHOD

The research method consists primarily of simple linear regression analysis used in a descriptive context. Since government contractors do not publish the profits earned on individual product lines, only the profits earned by the corporation as a whole are available. Corporate profits measured as a percentage of sales and of net worth, respectively, are extracted from The Value Line Investment Survey. In order to distinguish between profits earned on commercial business as opposed to defense business, the percentage of defense business (defense sales/total sales) is also extracted and used as an explanatory variable.

The initial phase establishes a technique for relating profitability to the amount of government business performed. The second goal was to investigate whether defense contractor profit variations could be partially explained by the percentage of capacity utilization within the aerospace industry. Capacity utilization figures came from the Federal Reserve Board, while defense business profit measures were taken from the results of phase one.

The final objective involves using risk analysis to help explain profitability variations. Two risk measures, Beta and PSI, were collected from Value Line and regressed against the percentage of government business to determine whether increased amounts of defense work correlate with risk. PSI is an index of a stock's price stability and is an indication of total risk while Beta measures a stock's "systematic" risk.

Risk was also analyzed from the perspective of the volatility of internal returns. A comparison was made between the variation of accounting return on investment (NI/NW) for commercial versus government business by calculating their respective standard deviations. Although a simple analytical technique, the results are no less convincing.

E. ANALYSIS, FINDINGS AND CONCLUSIONS

The remainder of the study describes the analysis of the data. Profit measures and percentages of government business were collected for approximately 25 firms per year over a twenty-two year span from 1961 to 1982. Having gathered such a large data base, it seemed imperative to exhaust the possible data arrangements in order to wring from them as much information as practicable. The detailed nature of the methodology and results sections reflect this underlying objective.

In order to clarify the presentation, the methodology, analytical results and conclusions sections are all organized under the same format and in the same sequence as the research questions. The sections are divided into; (1) profit versus percent government business, (2) profit versus capacity utilization and finally (3) risk analysis.

The findings support the concern expressed by many for the state of the defense industrial base. On average, profits for defense business as measured by NI/S and NI/NW have been lower than the same measures for commercial business. Although the net earnings difference is of greater magnitude and is more clearly supportable when measured as a percentage of sales, the difference is also statistically significant when measured as return on net worth.

With regard to capacity utilization, defense and commercial business profits have both risen during times of higher utilization. The most noteworthy finding in this section may be that defense profits rise faster than commercial profits, but never reach parity.

Risk analysis constituted the final section, and the findings indicate defense business is a more risky venture than its commercial counterpart. The volatility of returns proved to be greater for defense profits as did the instability of the defense-intensive firms' stock prices. The

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non-diversifiable "systematic" risk is not demonstrably different for the two alternative types of business.

The conclusions to be drawn from these findings have a common theme which does not bode well for the defense alternative. Defense contractors have been shown to realize a lower average return while incurring relatively higher risks. All other things equal, managers of aerospace firms would therefore be inclined to prefer commercial business over defense work. The harbingers of a "market of last resort," reduced competition, and a shrinking defense base admittedly cannot draw definitive support from these findings, but neither can we choose to ignore their message.

The inference to be drawn from the capacity utilization analysis is that aerospace firms are apparently able to negotiate higher profits on defense contracts when they don't need the business. This ability to "drive a hard bargain" apparently shifts to the Government's advantage when business levels fall off. The buying power of the Department of Defense has a significant influence on the aerospace industry in general, and is enhanced dramatically during periods of low demand from the private sector.

In short, there appears to be reason for concern but not for alarm. "Continuing concern" may be a more applicable comment, considering the long-term nature of the defense contracting profit controversy. An awareness of the

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problem over the years has done much to alleviate the con-
sequences. Defense managers must be kept aware of the
unique relationship between DOD and the aerospace manufac-
turers if the industry is to remain a strong and viable
component of the defense industrial base.

II. STRUCTURE OF THE STUDY

This chapter describes the approach used to carry out the research objectives specified in chapter 1.

A. THE SAMPLE

To begin this study, data were obtained from the Naval Air Systems Command (NAVAIR) concerning annual contract payments to aerospace firms from 1975 to 1982. This information was analyzed to identify which firms constituted the major contractors for Navy aerospace defense business. The companies listed in Table 2-1 were chosen as major contractors based on total dollars received as well as continuous involvement with NAVAIR throughout the period: (sequence of listing is not significant)

Table 2-1   REPRESENTATIVE NAVAIR CONTRACTORS

Boeing	Lockheed
Grumman	McDonnell Douglas
Vought	Litton
Beech	United Technologies
Teledyne	Raytheon
Hughes Aircraft	General Dynamics
General Electric	Ford Aerospace
North American Rockwell	Texas Instrument

This group of firms constituted a starting point for selection of the sample used for final analysis. The availability of data was another factor influencing the sample. Suitable data was available for a 22 year period from 1961 to 1982 from the Value Line Investment Survey. Under its aerospace industry section, Value Line provided financial data on approximately 25 firms each year. Comparison with the list above showed that Value Line was reporting on all of the major NAVAIR contractors, although a few were listed under the Multiform, Electrical, and Electronics sections.

Several additional factors combined to determine the final sample group. The entry and exit of new and old firms, and other corporate manipulations during the 22 year period made it impossible to track all but a very few specific firms over the entire period. It was therefore decided to use all of the data available in the Value Line Aerospace section as representative of the "industry."

The few NAVAIR contractors reported on under the Multiform, Electrical, and Electronics sections were also added to the sample--specifically General Electric, Texas Instrument, Litton, and Teledyne. Table 2-2 is a list of corporations for which data were collected and the years over which it was collected:

Table 2-2   VALUE LINE AEROSPACE CORPORATIONS

Corporation	Years Reported	Corporation	Years Reported
Beech	61-78	Teledyne	66-82
Cessna	61-82	McDonnell Douglas	66-82
Bendix	61-81	Ryan Aeronautical	67-67
Douglas	61-66	Sunstrand	67-82
Boeing	61-82	LTV Corp.	67-67
Garrett	61-62	LTV Aerospace	68-82
Martin Marietta	61-82	Curtiss Wright	69-75
Grumman	61-82	CCI	71-80
McDonnell	61-66	Southwest Airmotive	71-72
North American	61-66	TRE Corp.	72-82
Northrop	61-82	Rockwell	74-82
Piper	61-68	Lear Siegler	75-82
Republic	61-64	United Technologies	75-82
Rohr	61-82	Pneumo Corp.	76-82
Thomson Ramo	61-82	E-Systems	77-82
United Aircraft	61-74	Hazeltine	77-82
General Electric	61-82	Loral	77-82
Texas Instruments	61-82	Rockcor	78-82
Lockheed	62-82	Sanders Assoc.	78-82
American Bosch Arma/Ambac	62-77	Raytheon	79-82
		Moog Inc.	81-82
Fairchild Stratus/ Hiller	62-82	Atlantic Research	82
		Hexcel Corp.	82
General Dynamics	62-82	International Controls	82
Ling Temco Voight	62-66	Watkins-Johnson	82
Thiokol	62-81		
Litton	62-82		
Aerojet General	63-71		
Marquardt	64-67		
TRW Inc.	64-82		

After identifying the sample of firms to represent the aerospace industry, it was necessary to collect financial information with which to compare the profitability of defense versus commercial business.

B.   DATA SOURCE

The Value Line investment survey was chosen as the source of financial information specifically because it

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provided a statistic critical to this study--government business sales as a percentage of total sales. Use of this measure of involvement in government (or, conversely, non-government) business provides, through regression analysis against common measures of profit, the ability to compare which type of business, if either, is the more profitable. Two measures of profit were reported in the data from 1961 to 1968; profit margin and percent earned on (book) common equity (NI/NW). Profit margin is further defined as operating earnings before deduction of depreciation, interest and income tax, expressed as a percentage of sales. From 1969 to 1982, the format of the sales-based data was varied slightly and became net income/sales (NI/S).

The percentage of government business (%GOVTBUS) was not reported for every firm in every year.[1] When this piece of data was missing, the particular firm was excluded from the data set for that year. This did not constitute a significant problem because an average of 80% of the entries included the statistic. The firms listed in Table 2-2 are those for which the percentage of government business was regularly reported. A casual review of firms included in the sample is all that is needed to convince an informed

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[1]The partial omission of this statistic was another factor which prompted the use of data from all of the firms reported on in the Value Line's Aerospace Section.

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individual that this sample is a viable representative of the aerospace industry. It should further be understood that the percentage of government business is not necessarily entirely defense oriented (e.g. NASA is not), but that the percentage of non-defense government business in the aerospace field is limited, and should not detract from the main thrust of this study.

The desire to further explain profitability by hypothesizing a relationship between profit and the level of capacity utilization within the aerospace industry prompted the collection of the final piece of data. The average annual percentage of capacity utilization (%CAPUTIL) for the aerospace industry was recorded from data collected by the Federal Reserve System for each year from 1961 to 1982 inclusive.

C. REGRESSION ANALYSIS

1. Profit vs. Percent Government Business

The first phase of the data analysis involved regression of the two profit measures[2] NI/S and NI/NW, individually, as the dependent variable against %GOVTBUS as the

---

[2]Data from 1961 to 1968 were actually Profit Margin or earnings before interest, taxes and depreciation as a percentage of sales (EBITD/S) rather than NI/S. The distinction has no effect on the outcome of this study because only a comparison of relative profit levels is desired. The data are handled separately whenever combining it would introduce error. For simplicity, the profit to sales percentage will be referred to as NI/S.

independent variable. All regression analyses were per-
formed on a computer using a statistical program package
known as MINITAB. Three major pieces of information were
derived from the regression analysis; the equation of the
line (y=a+bx), the coefficient of determination r^2, and the
t-ratio of the coefficient b. The equations of the two
regressions, NI/S to %GOVTBUS and NI/NW to %GOVTBUS for each
year from 1961 to 1982, not only constitute a major result
of the profit vs. government business analysis, but are also
used as a major "source" of data for the profit vs. capacity
utilization analysis.

Phase two of the analysis was performed by first
determining the average profit as measured by both NI/S and
NI/NW, for each year and regressing it against the computed
average of the percentage of government business. This for-
mat reduced the data set to 22 values of NI/S, NI/NW; and
%GOVTBUS, one for each year. The result when using NI/NW
as the profit measure was a single equation, with related
statistics, to describe the annual average profit as a func-
tion of the annual average percentage of government business
performed. The regression analysis of the average NI/S
versus the average %GOVTBUS was handled in two parts, 1961
to 1968 and 1969 to 1982, respectively, because of the pre-
viously mentioned variation in the data format. This
resulted in two equations with related statistics for this
profit measure versus the single equation for NI/NW.

Phase three of the analysis was based on taking the aggregation technique one step further than averaging. The twenty-two years of data--477 observations--were lumped together to form one big set, eliminating any annual reference. Again the NI/S data had to be treated in two separate groups to account for the difference in magnitude between "profit margin" and NI/S, resulting in two equations for profit to sales and one equation for profit to net worth as a function of the percentage of government business.

In summary, the initial three phases resulted in regression equations which attempt to correlate the profitability of aerospace firms, by two measures, with the amount of government business in which they are involved, over a period of 22 years. The three phases could be described as annual, average, and aggregate respectively, to clarify the distinction between their particular data formats. Each phase has its own merits as well as drawbacks and selection of a particular technique depends on the degree to which the hypothesis to be supported is specified. The aggregate technique, for example, allows only a description of a general trend over the entire period rather than reference to a single year or group of years.

2. Profit vs. Capacity Utilization

Phase four of the analysis introduces the aerospace industry capacity utilization (%CAPUTIL) for the first time

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as an independent variable. A second major departure from the previous routine occurs in the way the dependent variables for this phase are derived.

Recalling that for each of 22 years there is an equation relating NI/S to %GOVTBUS as well as another relating NI/NW to %GOVTBUS, it is possible to evaluate these equations at the endpoints of the line. The outcome of this evaluation will be profit measures, NI/S and NI/NW, for both 0% and 100% government business, or in other words, profit measures as a function of all commercial or all governmental business. The derived data was arranged in the format of Table 2-3 prior to regression against %CAPUTIL.

Table 2-3   DERIVED PROFIT MEASURES FOR
                 GOVERNMENT AND COMMERCIAL BUSINESS

1961-1968	NI/S 0% GOVTBUS	NI/S 100% GOVTBUS
1969-1982	NI/S 0% GOVTBUS	NI/S 100% GOVTBUS
1961-1982	NI/NW 0% GOVTBUS	NI/NW 100% GOVTBUS
1961-1982	$\dfrac{\text{NI/S 100\% GOVTBUS}}{\text{NI/S \quad 0\% GOVTBUS}}$	$\dfrac{\text{NI/NW 100\% GOVTBUS}}{\text{NI/NW \quad 0\% GOVTBUS}}$

The objective of the regression analysis that followed was to determine whether the newly formed governmental, commercial, and ratio of governmental to commercial profit measures were correlated to the capacity utilization. The results of this particular section are potentially the most

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significant with regard to their implications for future defense contracting.

Phase five repeated the analysis done in phase four with one major modification. A smoothing technique[3] available within the MINITAB package was used to smooth the data. This technique is particularly applicable when data has been collected in a time series, as in this case. The major thrust of this analysis was to discover historical trends rather than to pinpoint a specific annual result, and therefore smoothing was considered to be complementary to the desired results.

Phase six is the final phase of the capacity utilization analysis. In the two preceding phases, profit measures derived from the resulting equations of Phase One were regressed in their "raw" and "smoothed" forms against the percentage of capacity utilization, which was also available in the same two forms. In phase six a distinct departure is made from these "derived" profit measures by returning to the average annual profit as determined during phase two. These average annual profits of the sample aerospace

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[3]Resistant smoothers are built up by successive applications of simple smoothers such as; running medians: where each value in the data set is replaced by the median of the data values immediately before it and after it. Hanning: this is a running average computed as $z(t)=0.25Y(t-1)+0.5Y(t)+0.25Y(t+1)$. Splitting: which uses a special method to remove flat spots which often appear after running medians. Special methods are also used to handle the two ends of the data sequence.

industry constitute a somewhat natural variable to be regressed against the annual capacity utilization figures, which are also an "industry" average. Results from this phase were expected to be highly indicative of industry trends, albeit subject to the inferential limitations imposed when discussing the "average firm."

Summarizing phases four through six, derived profit measures relating to either commercial or government business or ratios thereof, are regressed against the average annual percentage of capacity utilization in the aerospace industry. Phases four through six are distinguished by their respective data formats; raw and smooth "derived" data, and averaged data.

The analytical results are presented in a format very similar to the six phases previously described in this section. It is important in trying to follow the detailed description of results to remember the different phases and their respective groupings. The following outline in Table 2-4 may aid in clarifying the format of the presentation.

Table 2-4   FORMAT OF ANALYTICAL RESULTS PRESENTATION

Profits vs. Government Business

Independent Variable: %GOVTBUS

Dependent Variables: NI/S and NI/NW

Data Formats:

    1.   Annual
    2.   Averaged
    3.   Aggregated

Profit vs. Capacity Utilization

Independent Variable: %CAPUTIL

Dependent Variables:[5]

    Government Business Profits (GOVBUSPROF)

        NI/S - 100% GOVTBUS

        NI/NW - 100% GOVTBUS

    Commercial Business Profits (COMBUSPROF)

        NI/S - 0% GOVTBUS

        NI/NW - 0% GOVTBUS

Data Formats:

    1.   Derived - raw, smooth

        a.   GOVTBUSPROF
        b.   COMBUSPROF
        c.   GOVBUSPROF/COMBUSPROF

    2.   Averaged

---

[5]These new variables are "derived" from evaluating the two endpoints of the regression line equations which resulted from the initial annual analysis of NI/S and NI/NW vs. %GOVTBUS. The respective endpoint values are then proposed as data which is representative of the annual profitability of the alternate types of aerospace business--commercial and government.

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D. RISK ANALYSIS

In establishing a methodology to analyze the risks related to engaging in either commercial or governmental aerospace business, the major difficulty encountered is in defining from whose perspective the "risks" are to be evaluated.

Investors, bankers, managers, and government procurement personnel all have a slightly different viewpoint, and thus different opinions, on whether one type of business is more or less "risky" than another.

From the viewpoint of the firms, one of the most important measures of risk is the volatility of returns. Their ability to properly manage the firm's assets is often gauged by the steadiness of the rates of return reported to investors. For this reason a comparison was drawn between the spread of returns for all commercial business versus those for all government business, as measured by the standard deviation of each business line's respective ROI. The ROI data used in this analysis is the "derived" NI/NW data previously described in footnote number five.

Another perspective from which to analyze risk is that of the potential investor. Investors purchase equity securities based on their potential for future earnings as realized by dividends and/or increased stock prices. The volatility of these potential earnings is assessed by two

different measures reported by The Value Line Investment Survey; Beta and PSI.

Beta is a Greek letter used to denote the sensitivity of a stock's price to fluctuations in the general market. As such, the risk measured by Beta is "systematic" and cannot be reduced through diversification. This "systematic" risk is the component of risk for which the market must reward investors with higher rates of return, according to the "efficient market" theory. [Ref. 12] Systematic risk factors are economy related and are therefore typically external to any specific firm or industry. By its very nature then, a firm's Beta may be independent of the percentage of government business in which it is engaged. A simple regression analysis of Beta as the dependent variable against the %GOVTBUS as the independent variable is used in an attempt to test this contention. If systematic risk is independent of the type of business performed, it can be eliminated from the total risk equation, leaving only the "unsystematic" or firm-specific risk.

The Price Stability Index (PSI) is a number from zero to one hundred which measures the stability of a stock's price over the past five years. The PSI is Value Line's measure of total risk. Given that the analysis on Beta above eliminates the systematic portion of total risk from further consideration, then a definite correlation between PSI and

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%GOVTBUS through a second regression analysis would determine which type of business causes the higher "unsystematic" risk. The unsystematic risk which remains includes for example, a stock's sensitivity to developments peculiar to its industry and to its company's competitive position and financial condition.

Admittedly, from the standpoint of attracting equity capital, the risk component measured by Beta is, theoretically, the only relevant one. In this analysis, though, the potential investor was not initially proposed as a major party to the controversy, so his perception of risk is not really the issue. The risks that are truly relevant to this study's area of concern are unsystematic which are important to bankers, managers, and Government personnel in dealing with individual firms rather than large portfolios.

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III. ANALYTICAL RESULTS

A. PROFITS VS. GOVERNMENT BUSINESS

1. Annual Data

a. Net Income/Sales (1961-1982)

In general, the results of these regressions show conclusively that commercial business has been more profitable than government business during the last 22 years, as measured by NI/S. The strongest support for this statement can be found in the slopes of the regression equations. As seen in Table 3-1 the slope 'b' is consistently negative over the entire 22 year sample period. The negative slope is statistically significant at the 95% confidence level in all but four years through 1976. This finding is confirmed by observing the t-ratio values of greater than 2.00 in Table 3-1. For those four years the slope was statistically significant at the 90% confidence level. The regression equations from 1977-1982 are consistent in magnitude and direction with those which preceded them but they lack the t-ratio support which is needed to claim statistical significance.

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Table 3-1   NI/S vs. %GOVTBUS
Regression Equations (Y=a±bX) and Related Statistics

YEAR	a	b	t-ratio	r^2
1961	10.8	-0.049	-1.79	16.8
1962	13.8	-0.089	-8.40	77.1
1963	13.3	-0.094	-4.58	48.8
1964	15.0	-0.102	-5.34	60.0
1965	14.5	-0.091	-4.16	46.4
1966	12.9	-0.061	-3.34	42.6
1967	9.85	-0.040	-1.53	12.7
1968	11.9	-0.062	-2.34	28.2
1969	4.58	-0.026	-1.69	16.0
1970	4.92	-0.042	-2.79	37.4
1971	3.16	-0.021	-2.07	20.1
1972	4.66	-0.042	-2.80	32.9
1973	6.85	-0.074	-2.51	28.3
1974	4.86	-0.033	-3.77	48.7
1975	4.11	-0.023	-1.61	13.2
1976	5.27	-0.045	-2.96	31.5
1977	4.94	-0.017	-1.11	5.3
1978	5.21	-0.008	-0.55	1.4
1979	6.15	-0.014	-0.68	2.1
1980	6.64	-0.035	-1.30	7.1
1981	6.72	-0.041	-1.30	7.1
1982	5.48	-0.024	-1.21	5.7

b. Net Income/Net Worth (1961-1982)

   In contrast to the distinct relationship discovered between profit as measured by NI/S and government business, the results using NI/NW are, statistically speaking, inconclusive. As seen in Table 3-2 the values of the t-ratio confirm that over the 22 year period there are only three occasions (1972, 1980, 1981) when the results can be said to be significant at the 95% confidence level. All of the other 19 years are statistically less conclusive. This lack of a statistically supportable relationship between

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NI/NW and %GOVTBUS essentially precludes any further deduc-

tions which <u>require using a single year's data as evidence</u>.

Table 3-2   NI/NW vs. %GOVTBUS
Regression Equations (Y=a+bX) and Related Statistics

Year	a	b	t-ratio	r^2
1961	8.15	0.046	0.95	5.4
1962	10.5	0.021	0.67	2.1
1963	11.3	0.008	0.21	0.2
1964	14.9	-0.024	-0.61	1.9
1965	15.5	-0.011	-0.26	0.3
1966	16.1	-0.012	-0.32	0.7
1967	14.8	-0.016	-0.33	0.7
1968	13.0	0.007	0.14	0.1
1969	13.5	-0.022	-0.32	0.7
1970	14.5	-0.066	-1.07	8.1
1971	7.36	0.002	0.06	0.0
1972	12.9	-0.094	-2.02	20.3
1973	14.0	-0.068	-1.36	10.4
1974	13.6	-0.018	-0.44	1.3
1975	11.8	-0.011	-0.25	0.4
1976	14.1	-0.007	-0.13	0.1
1977	13.1	0.069	1.40	8.2
1978	14.6	0.052	1.35	7.9
1979	19.1	-0.032	-0.70	2.3
1980	21.4	-0.133	-3.86	40.4
1981	20.5	-0.135	-2.58	23.3
1982	11.6	0.010	0.25	0.3

Nonetheless, there are certain observations,

which, due to their repetitive nature, become noteworthy.

For example, plots of NI/NW vs. %GOVTBUS from year to year

show a similar wide degree of scatter about a relatively

flat regression line. The fact that the r^2 and t statistics

do not support the credibility of this line as a predictor,

does not entirely detract from the intuitive conclusion that

the difference in profitability between commercial and

government aerospace ventures, although much smaller than
that measured by NI/S, favors commercial business.

2. Averaged Data

a. Net Income/Sales

The results of the regressions using the average
of the NI/S and %GOVTBUS from each year are statistically
inconclusive. Instead of reaffirming the original results,
the averaging process in this case resulted in two equations
which show opposite results. The results of the regression
of averaged data from 1961-1968 is consistent with prior
results but the results of the 1969-1982 regressions show
that the profitability of commercial business is less than
that of the government. It is regrettable that the data
sets must be artificially separated at the 1968 to 1969
point due to the change in the manner in which NI/S was
reported for this creates a distraction in the analysis.

The most important result from this phase may be
the insight it provides into the errors which may be intro-
duced by the averaging process. Ironically, while attempt-
ing to deduce more on a general basis about the "average"
profitability, the results of the overall "average" regres-
sion equation turn out to be statistically inferior to the
parts which make it up by a sizeable margin. Comparison of
the r^2 and t statistics for the averaged data from 1961-1968
with the statistics from the annual regressions dramatically

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conveys this message. Based on the problem arising from the averaging process in this instance, the credibility of the already statistically insignificant 1969-1982 results are further diminished.

   b. Net Income/Net Worth 1961-1982

        Although the regression equation, $Y=13.0-0.0021$ ($r^2=0.0$, $t=0.03$) is again statistically insignificant the observation of an almost negligible slope combined with a Y-intercept consistent with expected results is again note-worthy. Beyond this it would be fruitless to elaborate except to say that the "averaged" results of NI/NW were consistent with the "annual" results.

   3. Aggregated Data

   a. Net Income/Sales 1961-1968 and 1969-1982

        In contrast to the departure from expected results which occurred when averaging the data, the results of aggregating mirrored the annual image of profitability versus government business. The equations obviously show the effects of the years which make them up. The profitability of commercial business, as measured by NI/S, is again shown to be higher than that of government business. Figures 3-1 and 3-2 show the statistically significant results for the periods 1961-1968 and 1969-1982, respectively.

   b. Net Income/Net Worth 1961-1982

        The aggregation of twenty two years of data into one large set, ignoring the annual format in which it was
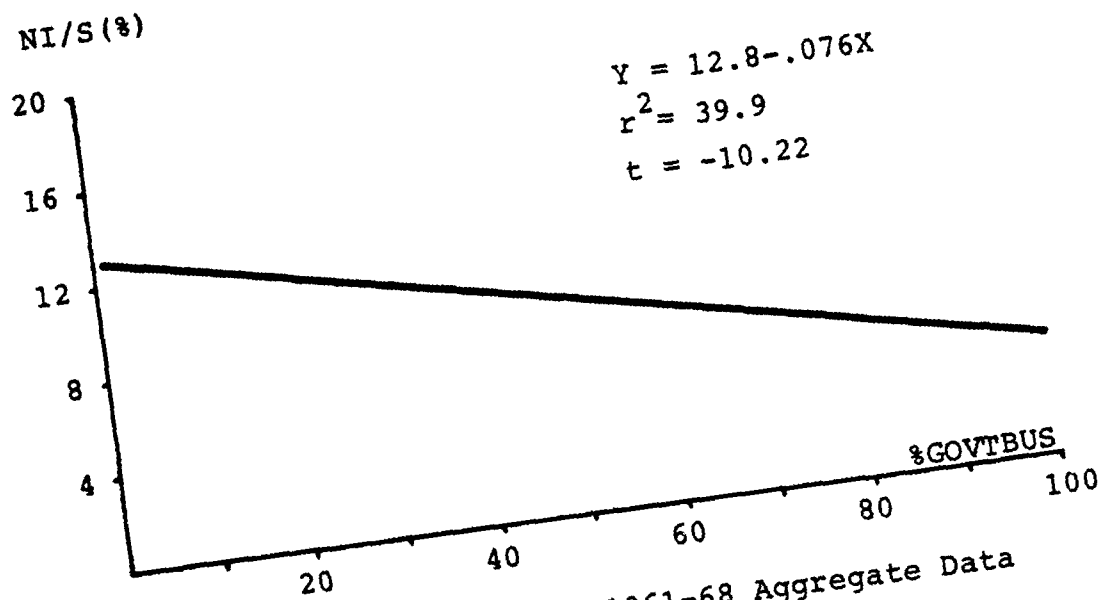
NI/S(%)

$$Y = 12.8 - .076X$$
$$r^2 = 39.9$$
$$t = -10.22$$

Fig. 3-1 NI/S vs. %GOVTBUS 1961-68 Aggregate Data

NI/S(%)
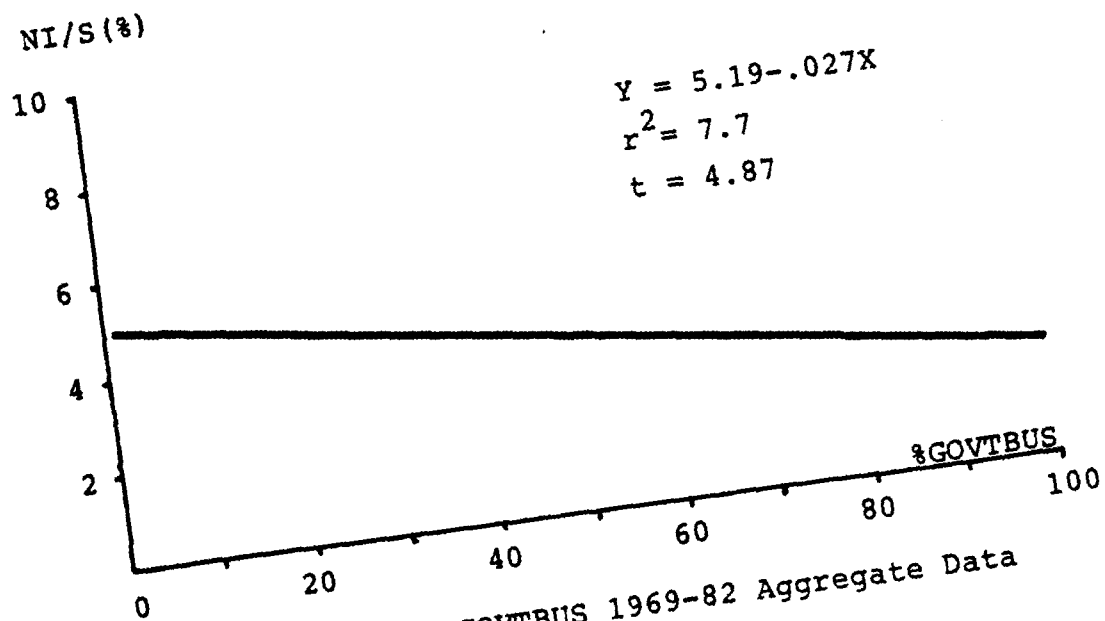
$$Y = 5.19 - .027X$$
$$r^2 = 7.7$$
$$t = 4.87$$

Fig. 3-2 NI/S vs. %GOVTBUS 1969-82 Aggregate Data

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collected, was an attempt to conclude something about the
period as a whole, in light of the reluctance of the indi-
vidual years to testify.

The resulting regression equation indicates that
for the whole period the profitability of commercial busi-
ness, as measured by NI/NW, has been higher overall than
that of government business, as seen in Figure 3-3. The
t-ratio statistic supports this finding at the 95% confidence
level. The r^2 statistic is particularly low because it has
an inverse relation to the number of observations (n) used,
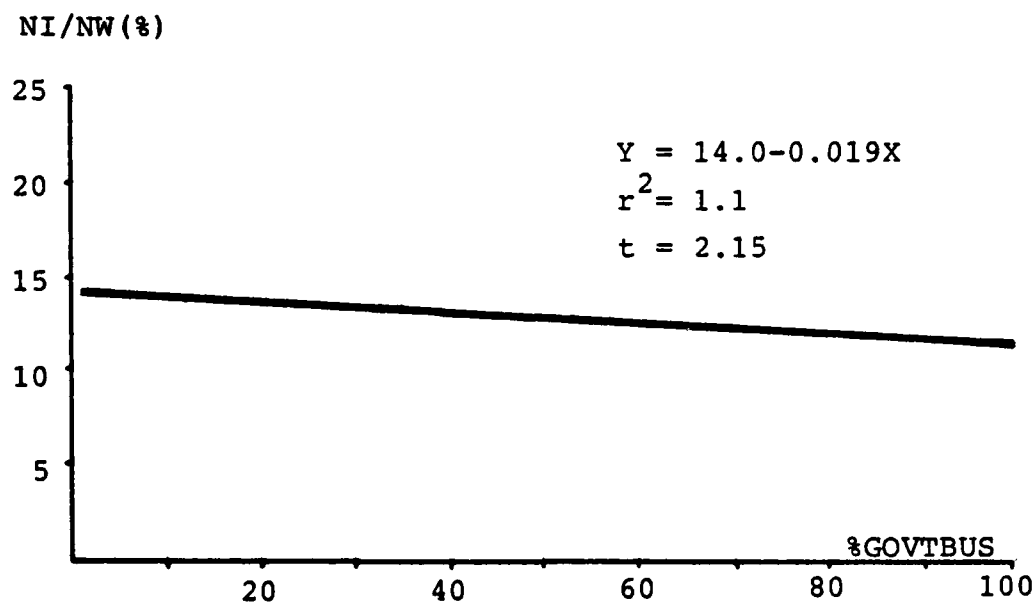which in this case was very high (n=426).

NI/NW(%)

Fig. 3-3 NI/NW vs. %GOVTBUS 1961-82 Aggregate Data

4. Profit vs. Government Business Summarized

In summary, aerospace industry profitability, as measured by NI/S, has been shown to be negatively related to the percentage of government business. This relationship has occurred on a consistent basis throughout the period under study and is wholly supported by the annual and aggregate regression analyses. On the other hand, when trying to distinguish between the profitability levels of commercial versus government business using NI/NW, the results are not so clear-cut. The most consistently observed result of the analyses in this area is that in any given year the profitability level is not well correlated to the percentage of government business performed. However, there was a statistically significant negative relationship established in the aggregated data analysis which showed commercial returns on net worth exceeding defense returns.

B. PROFITS VS. CAPACITY UTILIZATION

In general, the results of the regression analyses conducted show that profitability and capacity utilization, within the aerospace industry, are positively related. This result was observed on a consistent basis throughout the study, regardless of the profit measure used. The mix of DOD versus commercial business, however, affects the degree to which this observation is statistically supportable.

1. Derived Data vs. Capacity Utilization

As previously described, the dependent variables used in the analyses were derived from evaluating the end-points of the original regression evaluations--NI/S and NI/NW vs. %GOVTBUS. This manipulation provided annual measures of profitability, by both NI/S and NI/NW for either government or commercial business. An additional feature brought to bear on these results is the smoothing technique. The raw and smooth results of phases four and five of the analysis are presented together in the following sections (a), (b), and (c) to simplify what could be a rather unwieldy description.

a. Government Business Profitability vs. Capacity Utilization

Profits which aerospace firms experience on Government contract work rise with rising utilization of capacity. In other words, the busier the firms are the more profitable they are. This result was found to be true for both measures of profit, NI/S and NI/NW. As expected, the smoothing technique enhanced the statistical quality of the results by significantly reducing the data scatter.[4] Again due to the difference in magnitude between the NI/S data for

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[4]The smoothing technique did have a negative, albeit predictable impact on the Durbin-Watson statistic, which measures autocorrelation of "tracking" of the data. Smoothing, by its very nature, links each data values collected in the time series to their immediate neighboring values, producing the trend.

the two periods 1961-1968 and 1969-1982, the analysis of
NI/S vs. %CAPUTIL is conducted in two stages.

The results of the regressions using both raw
and smoothed data are presented in Table 3-3.

Table 3-3   GOVTBUSPROF vs. %CAPUTIL
Regression Equations (Y=a+bX) and Related Statistics

Profit Measure	Year	Raw(R) Smooth(S)	a	b	t-ratio	r^2
NI/S	1961-68	R	2.49	0.039	0.82	10.0
		S	2.19	0.042	3.65	69.0
NI/S	1969-82	R	-7.34	0.132	2.68	37.4
		S	-20.6	0.313	5.96	74.7
NI/NW	1961-82	R	-0.462	0.162	1.59	11.2
		S	-5.5	0.228	2.93	30.0

b. Commercial Business Profits vs. Capacity
    Utilization

Evaluating the NI/S and NI/NW vs. %GOVTBUS equa-
tions at the Y-intercept resulted in an annual measure of
commercial aerospace profitability. The regression of these
commercial business profit measures against the percentage
of capacity utilization resulted in a positive correlation,
as was the case in the preceding government business sec-
tion. Commercial business results mirror those of govern-
ment business with the exception that neither the raw nor
smoothed data versions of the 1961-68 NI/S results were
statistically significant. The raw and smoothed data
results are presented in Table 3-4.

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Table 3-4   COMBUSPROF vs. %CAPUTIL
Regression Equations (Y=a+bX) and Related Statistics

Profit Measure	Year	Raw (R) Smooth (S)	a	b	t-ratio	r^2
NI/S	1961-68	R	13.8	-0.009	-0.12	0.2
		S	9.13	0.048	0.74	8.4
NI/S	1969-82	R	-1.08	0.092	2.63	36.6
		S	-5.58	0.147	4.87	66.4
NI/NW	1961-82	R	-4.93	0.242	3.33	35.7
		S	2.23	0.159	2.11	18.2

For comparative purposes, government business profits (GOVBUSPROF) and commercial business profits (COMBUSPROF) are plotted against the percentage of capacity utilization (%CAPUTIL) using both profit measures, NI/S and NI/NW, in figures 3-4 and 3-5 respectively. The plot of NI/S vs. %CAPUTIL in figure 3-4 is for the results of the 1969-82 period where the NI/NW plot covers 1961-82. In both cases GOVBUSPROF is shown to rise at a faster rate than COMBUSPROF.

c. Government/Commercial Profit Ratio vs. %CAPUTIL

Having treated the profit measures individually as indicators of their respective types of business the next step was to form a ratio of the endpoints of each line. The magnitude of this ratio, as measured by NI/S was found to rise with increasing utilization of capacity in the aerospace industry, inferring that firms have, on average, been
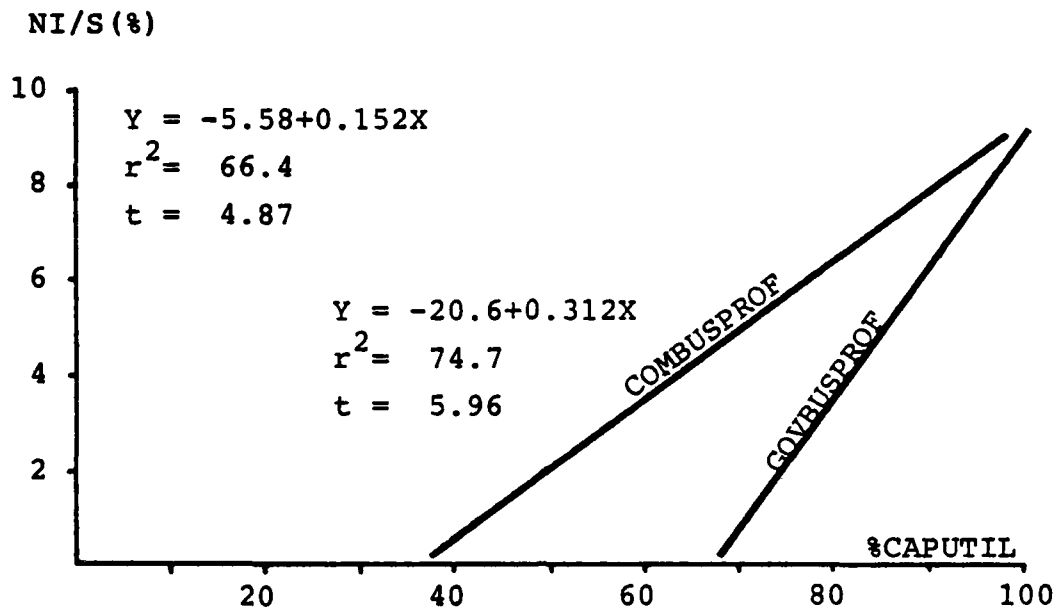
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NI/S(%)

Fig. 3-4   GOVBUSPROF and COMBUSPROF vs. %CAPUTIL (NI/S)
            1969-82
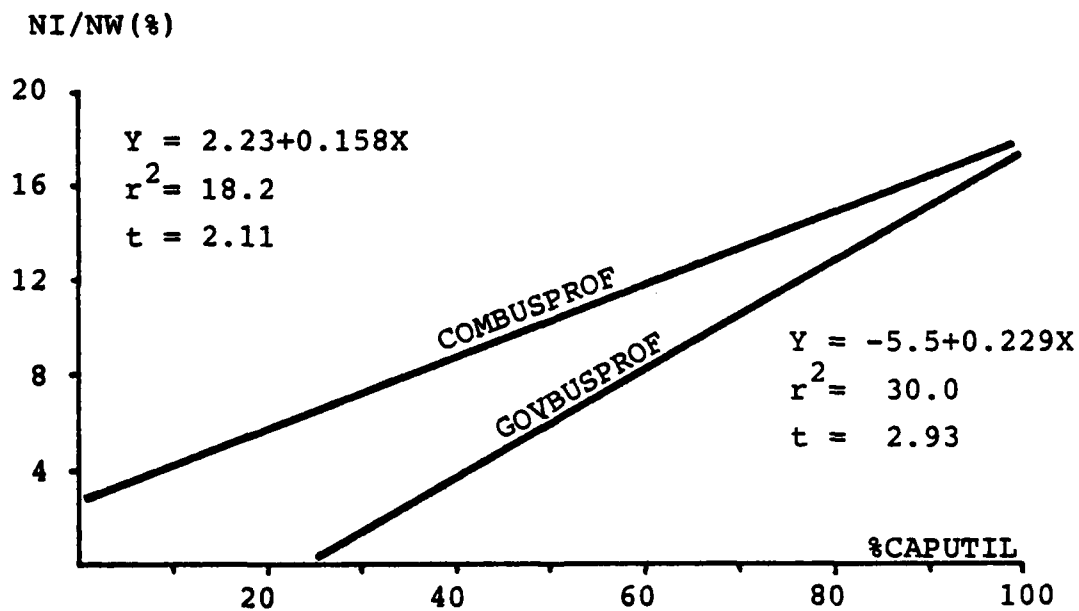
NI/NW(%)

Fig. 3-5   GOVBUSPROF and COMBUSPROF vs. %CAPUTIL (NI/NW)
            1961-82

able to negotiate higher profits on defense contracts when they were, relatively speaking, busier. The results of the regression analysis which used NI/NW to form the ratio were not statistically significant, but the trend was similar. Figure 3-6 provides a graphical display of the relevant results using the NI/S ratio.

It is noteworthy that the magnitude of the profit ratio at <u>full</u> capacity shows that government business would still be only about two-thirds as profitable as commercial business.

2. Averaged Data vs. Capacity Utilization

The average of both NI/S and NI/NW for each year were regressed against the average annual capacity utilization percentage. The results were consistent with the previous findings that showed a positive relationship between profitability and utilization of capacity. The sole drawback occurred when using the average of NI/S for the 1961-1968 period which was found to not be statistically significant. The results of the two significant equations from these analyses are shown in figures 3-7 and 3-8.

3. Profit vs. Capacity Utilization Summarized

In summary, the "derived" profit measures of the two types of aerospace business, commercial and government, have both been shown to rise with increased capacity utilization. The more significant result is seen when comparing the rates
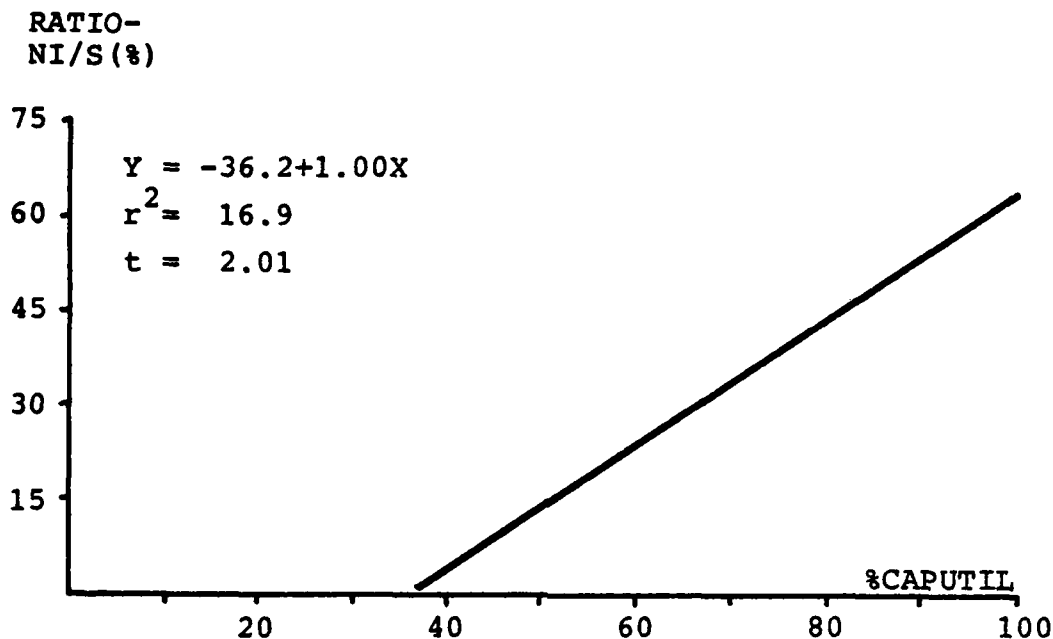
Fig. 3-6 GOVBUSPROF/COMBUSPROF vs. CAPUTIL (NI/S)

at which the profits (NI/S and NI/NW) rise. Government
business or "defense contracting" profits rise at a faster
rate than commercial profits as the aerospace industry's
capacity is more fully employed. Although parity between
the final profit levels is a rare occurrence, the implica-
tion is that commercial business would not so easily be dis-
tinguished as the more profitable during busy periods. The
averaged data results simply support the finding of
increased profitability with rising utilization, regardless
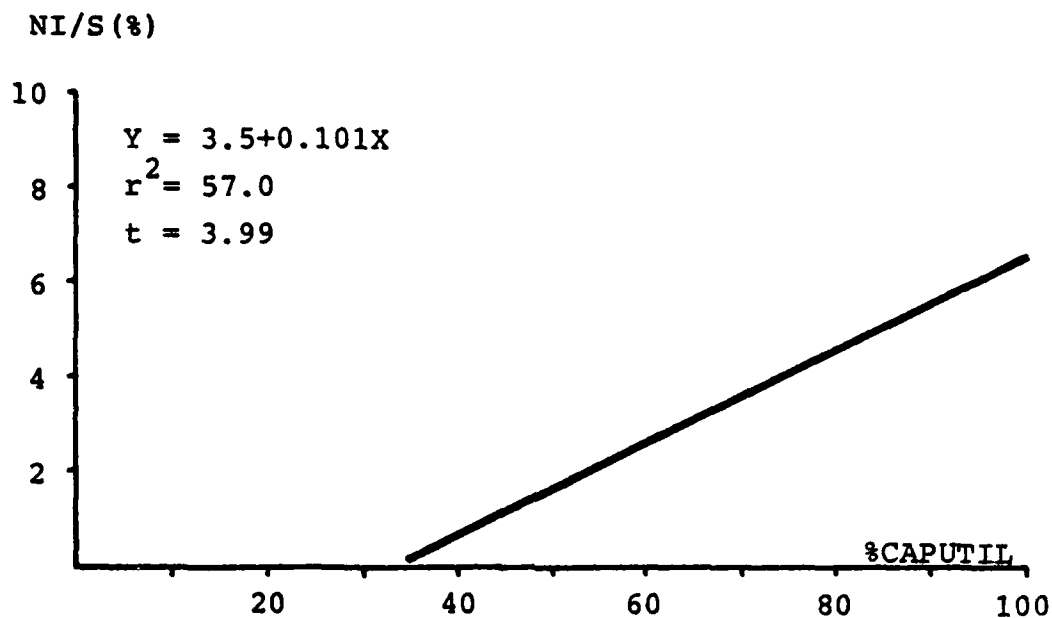of the type of business or profit measure.

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NI/S(%)

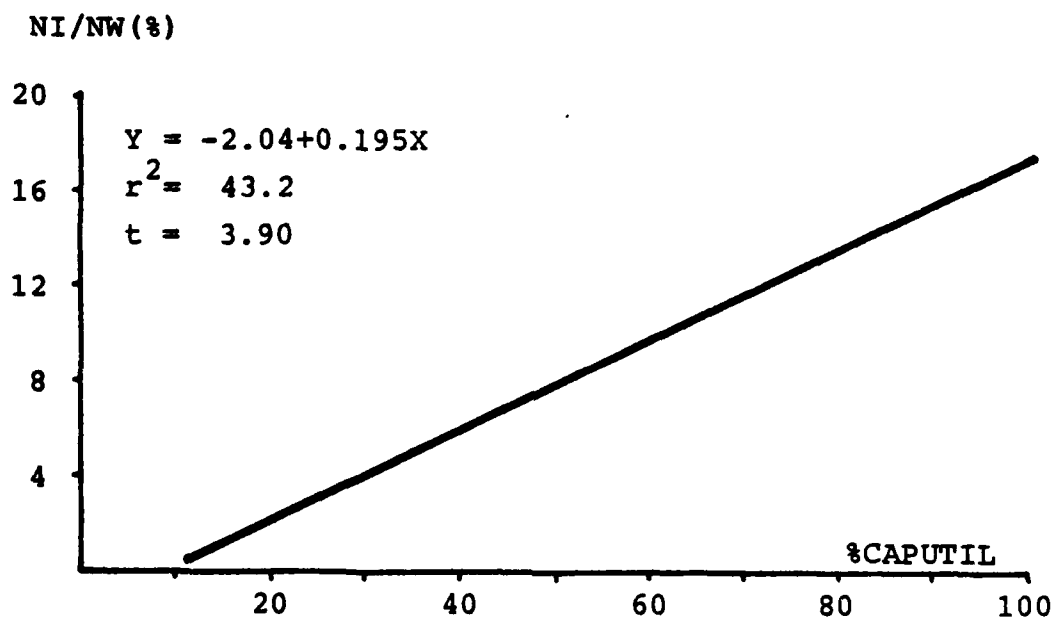Fig. 3-7   NI/S vs. %CAPUTIL Averaged Data 1969-82

NI/NW(%)

Fig. 3-8   NI/NW vs. %CAPUTIL Averaged Data 1961-82

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C. RISK ANALYSIS

1. Volatility of Returns

The volatility of returns was measured by comparing the variability of the annual ROI for commercial business with that of government business. The twenty-two years of values of NI/NW derived for both all commercial and all government business were averaged and the range of values measured by standard deviation. The average NI/NW and standard deviation for defense work were 11.97% and 4.02, respectively. The comparable commercial figures were 13.93% and 3.41.

This finding constitutes a paradox with significant implications. Not only have average returns been lower for DOD business but the risks as viewed by managers have been somewhat higher. The wider spread for government returns indicates that there is a greater gap between the "winners" and "losers" in defense contracting than in the commercial field.

This may support the argument that some firms realize "excessive" profits on defense contracts but the implication for the defense industrial base as a whole is more serious. The "winners" will view defense contracts as comparable to commercial endeavors in profitability and continue to compete for defense work. On the other end of the spectrum, the "losers" whose returns have been below average,

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will likely opt not to compete. In other words, the wider spread on a lower average return will tend to limit competition for defense contracts.

2. Beta and PSI vs. %GOVTBUS

As noted in the methodology section, "Beta" measures the correlation of a stock's price fluctuation with the general market. Unsystematic risk is assumed to be "diversified away" by holding large portfolios consisting of stocks from many different industries. Unfortunately bankers making loans, managers trying to manage, and government personnel trying to procure a weapon system are not necessarily concerned with the risks incurred by large institutional investors on their total portfolios.

The suspicion that Beta would be somewhat naturally unrelated to the amount of government business performed is borne out by the results of the regression analysis of BETA against the %GOVTBUS. The equation has a Y-intercept of 1.20 and a slope of 0.0001 which is combined with an r^2 and t-ratio of 0.1% and 0.12 respectively. Therefore we can conclude that there is no statistically significant correlation between risk and the amount of defense contracting performed as measured by Beta. If a relationship can be established between total risk and %GOVTBUS, the risk being measured must therefore be of an unsystematic nature.

The result of regressing PSI against %GOVTBUS showed that there is a definite relationship between total risk and

the amount of government business performed. With an r^2 and t-ratio of 21.6% and -2.68 respectively, there is statistical evidence that more total risk is incurred with defense contracting than with commercial work. The coefficient is -0.38 which would result in a reduction of a firm's PSI rating by 3.8 could be expected from a 10% increase in %GOVTBUS. Having essentially eliminated systematic risk as a function of %GOVTBUS, the variation of stock price stability with %GOVTBUS can be said to be a result of non-market forces.

In essence then, the higher the percentage of government business performed, the more unstable a firm's stock price becomes, because the company is operating at greater risk. This may further be attributed to the defense firm's being, for example, more sensitive to developments peculiar to the industry, in a less competitive position than its peers, or in more tenuous financial condition.

Whatever variables are contributing to the higher instability in the stock prices, overall results point towards defense contracting as being riskier than commercial work.

IV. CONCLUSIONS

A. PROFITABILITY OF DEFENSE VS. COMMERCIAL BUSINESS

In this study the objective has been to provide answers to several controversial questions through analysis of existing data. The first question was how profitable the major aerospace firms are in their defense versus nondefense business. The most vocal participants in this debate over the profitability of defense contracts have tended to gravitate toward the extreme opposite viewpoints. Congressmen and Contracting Officers, as guardians of the public purse, sometimes argue that defense contractors enjoy "excessive profits" while the opposition, from various camps, decries low profits as the cause of numerous ailments, including an alleged erosion of the defense industrial base.

The analytical results show that the answer to this question lies somewhere in between. Although profitability as measured by NI/S was found to be higher for commercial ventures, every firm in the sample was, in fact, doing some percentage of both types of business. Given this condition, a quantitative comparison between commercial and defense profits using the endpoint levels is unrealistic. In other words a firm with a 70%-30% mix of commercial to government business would still realize a higher profit than its 30%-70%

counterpart, but the magnitude of the difference would be significantly reduced.

As stated in the analytical results, the difference in profitability, as measured by NI/NW, was smaller, but the edge goes to commercial business when the entire study period is viewed as a whole. Aggregating the data did provide an important insight into the relative profitability of the two types of business over the entire period but the parties to the argument don't normally refer to twenty-two year averages in supporting their positions. They are more likely to be referring to the immediate past few years in discussing profitability trends. Using this time frame the answer to the questions of "which is more profitable" and "to what degree" depends entirely on "when" the question is posed. The plot of the smoothed ratio of government to commercial business profits over time in figure 4-1 clearly illustrates the time dependence of the answer to this argument.

The other pitfall in talking about average profitability trends is that the parties to the controversy normally are not only time-specific but they also tend to be firm-specific. Obviously the returns for each contractor are not all the same when conducting government business. A limited analysis of the data available on individual firms showed for example, that while Boeing's and McDonnell Douglas's
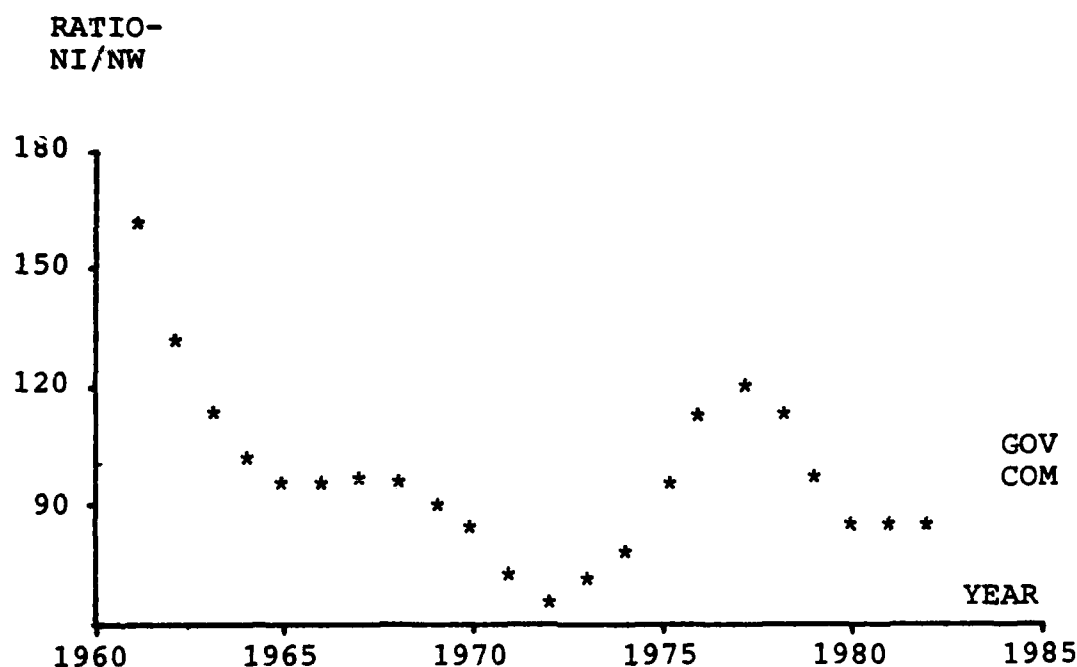
RATIO-
NI/NW

180

150

120

90

GOV
COM

YEAR

1960   1965   1970   1975   1980   1985

Fig. 4-1   GOVBUSPROF/COMBUSPROF vs. Time(NI/NW)   1961-82

profitability fell with the amount of defense contracting

performed, Lockheed's and Martin Marietta's were essentially

flat and Grumman's and Northrop's rose. So while on average,

commercial profits, as measured by NI/NW, were slightly

higher than governmental, consideration of specific time

intervals and specific firms introduces sizable variations

in the answer.

B. PROFITABILITY VS. CAPACITY UTILIZATION

The ability of the government to "drive a hard bargain"

with respect to profit levels is apparently enhanced during

periods of relatively slack business activity. Aerospace

firms who, during busier periods, would prefer to use less

profitable defense work as a "filler," find during slow times that DOD becomes the only buyer of any "substance." Because very few firms can "risk" becoming heavily dependent on defense contracting, due in part to the vagaries introduced by politics, they must regularly vary their percentage of DOD sales with the changing business climate.[6]

The implications for defense contracting personnel is that when business is booming, firms will naturally attempt to achieve profit levels from defense contracts which reach parity with their commercial profit levels. It is at this point where the results of the government's actions seem paradoxical. It is extremely difficult to blend a long-term strategy of providing sufficient incentive to maintain an advancing technological competence and physical production capability with a short-term one which ingrains a zeal for parsimony in contract negotiations.

Frugality with the public dollar is a virtue to the taxpayer, but taking advantage of a powerful negotiating position could have a deleterious impact on both the current as well as future contracts. It is likely that the contractor who is forced to accept a lower profit will strive to increase his return by minimizing his investment, which will

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[6]Politics can affect not only whether or not an item will be procured at all but also when, how many, and from whom it will be procured. Grumman may be the only aerospace firm which is wholly dependent on defense contracting business.

inevitably decrease his productivity and ultimately increase
acquisition costs to the government. [Ref. 5]

A second alternative to minimizing equity investment is
for the contractor to simply not engage in defense con-
tracting. Both of these alternatives are forms of erosion
of the defense base. The former reduces the quality of the
competition for defense business while the latter reduces
the quantity. It is therefore incumbent upon the government
to consider the symbiotic nature of its relationship with
the aerospace industry when negotiating profit levels, par-
ticularly during periods of reduced activity.

C. PROFITABILITY VS. RISK

The objective of the risk analysis was to use the
results to explain any differences in profitability which
were discovered. It is a generally accepted financial pre-
cept that the rate of return on investment (ROI), as meas-
ured by NI/NW, should be positively correlated with the
amount of risk incurred.

As previously discussed, the perception of risk is a
matter of perspective. The analytical results show as
expected that the securities markets do not assess either
type of business as being more sensitive than the other to
market fluctuations, as measured by beta. As noted in the
methodology, beta is applicable to diversified portfolios
where, on average, it can explain about 30% of most stock

price changes in response to factors which affect the market as a whole. The Price Stability Index (PSI) is on the other hand a measure of a single stock's price volatility. In this case the stock prices of firms engaging in higher percentages of government business were shown to be more volatile--or more risky--based on the past five years.

Another result shows that the variability of returns for government business as measured by the wider standard deviation of NI/NW is also indicative of the individual corporation's financial risk. The final piece of evidence with regard to variability of returns is the comparison of the smoothed data plots in figures 4-2 and 4-3 of commercial and governmental business profits (NI/NW) against time. Clearly the commercial ROI has not experienced the degree of fluctuation that has characterized the government business returns.

The beta and PSI analysis are applicable to the more recent past, while the variability of returns is a product of the entire period. The shape of the government ROI curve is a graphic example of the "roller coaster" ride of which defense contractors often complain.

The most accurate conclusion to be drawn from this risk analysis may not be the most obvious. Where as the majority of the results support a conclusion of higher risk for defense contractors, it may be safer to make the more
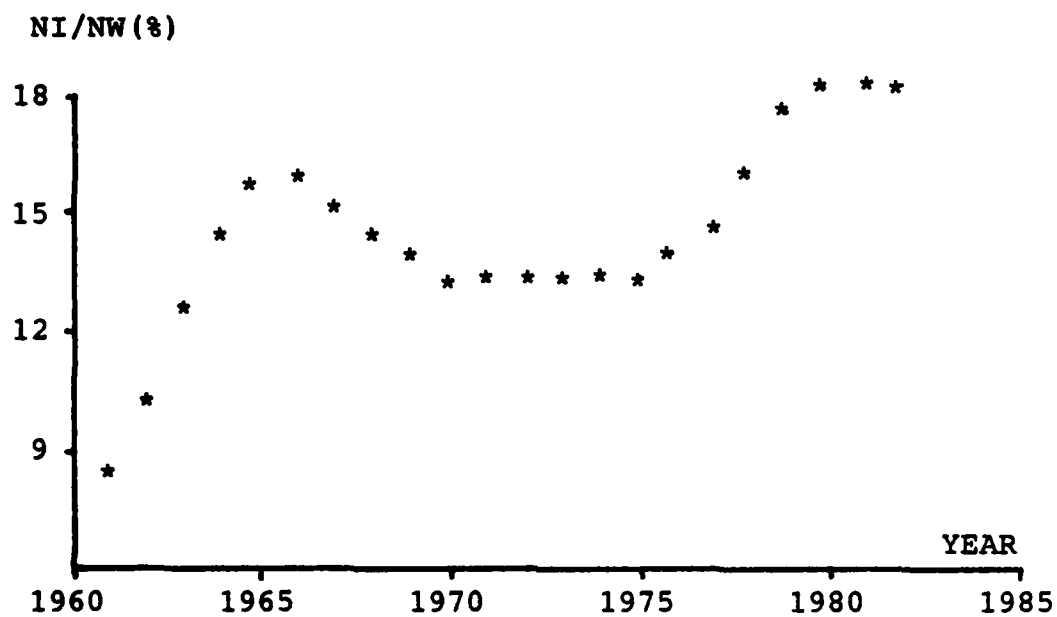
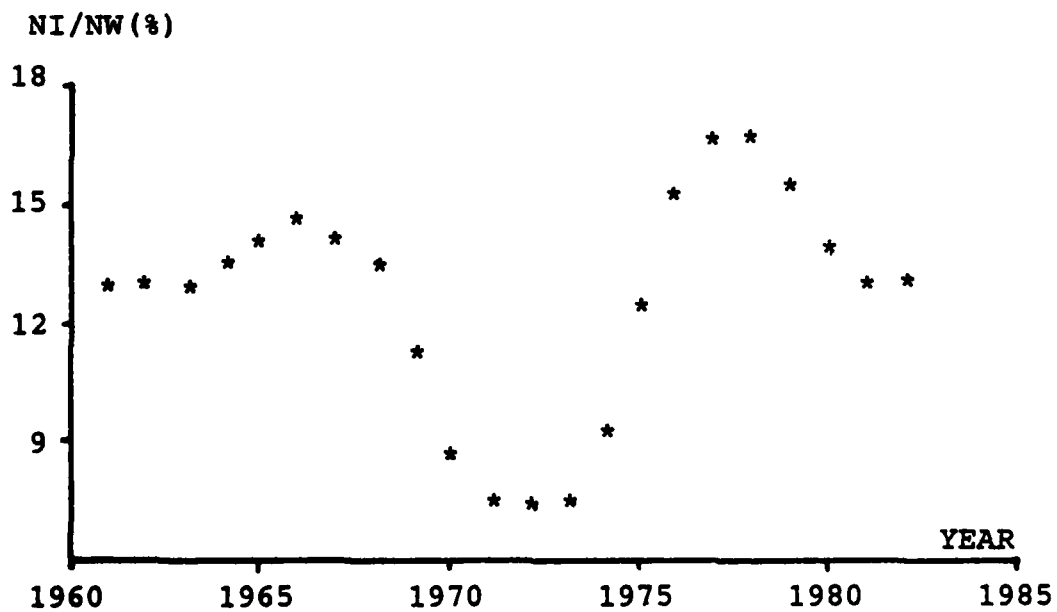Fig. 4-2   GOVBUSPROF vs. Time (NI/NW)   1961-82

Fig. 4-3   COMBUSPROF vs. Time (NI/NW)   1961-82

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conservative statement that the results <u>don't</u> support higher

risks for commercial business. In other words, if commer-

cial profits have been higher it hasn't been a natural con-

sequence of being exposed to higher risks. Conversely,

lower returns on government business are more than liklely

a result of procurement policies designed to limit profit

levels rather than the expected result of assuming less risk.

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